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L6	L3 not l5	33	L6
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L2	L1 and (CRC or counter-rotating-current or "counter rotating current")	4102	L2
L1	((magnetic adj resonance) or MRI or NMR)	132361	L1

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Search Results - Record(s) 1 through 33 of 33 returned.

☐ 1. Document ID: US 20020102638 A1

L6: Entry 1 of 33 File: PGPB Aug 1, 2002

PGPUB-DOCUMENT-NUMBER: 20020102638
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020102638 A1

TITLE: Nucleic acids, proteins, and antibodies

PUBLICATION-DATE: August 1, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Rosen, Craig A.	Laytonsville	MD	US	
Ruben, Steven M.	Olney	MD	US	
Barash, Steven C.	Rockville	MD	US	

US-CL-CURRENT: 435/69.1; 435/320.1, 435/325, 530/350, 536/23.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 2. Document ID: US 20020081582 A1

L6: Entry 2 of 33 File: PGPB Jun 27, 2002

PGPUB-DOCUMENT-NUMBER: 20020081582
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020081582 A1

TITLE: METHOD AND APPARATUS FOR CHEMICAL AND BIOCHEMICAL REACTIONS USING PHOTO-GENERATED REAGENTS

PUBLICATION-DATE: June 27, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
GAO, XIAOLIAN	HOUSTON	TX	US	
ZHOU, XIAOCHUAN	ANN ARBOR	MI	US	
GULARI, ERDOGAN	ANN ARBOR	MI	US	

US-CL-CURRENT: 435/6; 422/129, 422/134, 435/7.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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3. Document ID: US 20020028923 A1

L6: Entry 3 of 33 File: PGPB Mar 7, 2002

PGPUB-DOCUMENT-NUMBER: 20020028923
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020028923 A1

TITLE: IDENTIFICATION OF GENETIC TARGETS FOR MODULATION BY OLIGONUCLEOTIDES AND GENERATION OF OLIGONUCLEOTIDES FOR GENE MODULATION

PUBLICATION-DATE: March 7, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
COWSERT, LEX M.	CARLSBAD	CA	US	
BAKER, BRENDA F.	CARLSBAD	CA	US	
MCNEIL, JOHN	LA JOLLA	CA	US	
FREIER, SUSAN M.	DIEGO	CA	US	
SASMOR, HENRI M.	ENCINITAS	CA	US	

US-CL-CURRENT: 536/23.1; 435/6, 536/24.5

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

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4. Document ID: US 20010029049 A1

L6: Entry 4 of 33 File: PGPB Oct 11, 2001

PGPUB-DOCUMENT-NUMBER: 20010029049
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20010029049 A1

TITLE: "SELF - ENCODING SENSOR WITH MICROSPHERES "

PUBLICATION-DATE: October 11, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
WALT, DAVID R.	LEXINGTON	MA	US	
DICKINSON, TODD A.	SAN DIEGO	CA	US	

US-CL-CURRENT: 436/518

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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5. Document ID: US 6426184 B1

L6: Entry 5 of 33 File: USPT Jul 30, 2002

US-PAT-NO: 6426184
DOCUMENT-IDENTIFIER: US 6426184 B1

TITLE: Method and apparatus for chemical and biochemical reactions using

photo-generated reagents

DATE-ISSUED: July 30, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Gao; Xiaolian	Houston	TX		
Zhou; Xiaochuan	Ann Arbor	MI		
Gulari; Erdogan	Ann Arbor	MI		

US-CL-CURRENT: 435/6; 432/129, 432/134, 435/7.1, 530/333, 530/334, 530/335, 530/336, 530/337

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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6. Document ID: US 6404199 B1

L6: Entry 6 of 33 File: USPT Jun 11, 2002

US-PAT-NO: 6404199
DOCUMENT-IDENTIFIER: US 6404199 B1

TITLE: Quadrature RF coil for vertical field MRI systems

DATE-ISSUED: June 11, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Fujita; Hiroyuki	Highland Heights	OH		
DeMeester; Gordon D.	Wickliffe	OH		

US-CL-CURRENT: 324/318; 324/307, 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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7. Document ID: US 6351121 B1

L6: Entry 7 of 33 File: USPT Feb 26, 2002

US-PAT-NO: 6351121
DOCUMENT-IDENTIFIER: US 6351121 B1

TITLE: Rapid high-accuracy magnetic resonance imaging

DATE-ISSUED: February 26, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kaplan; Jerome I.	Indianapolis	IN	46205	

US-CL-CURRENT: 324/307; 324/300, 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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8. Document ID: US 6346813 B1

L6: Entry 8 of 33 File: USPT Feb 12, 2002

US-PAT-NO: 6346813
DOCUMENT-IDENTIFIER: US 6346813 B1

TITLE: Magnetic resonance method for characterizing fluid samples withdrawn from subsurface formations

DATE-ISSUED: February 12, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kleinberg; Robert L.	Ridgefield	CT		

US-CL-CURRENT: 324/303

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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9. Document ID: US 6316941 B1

L6: Entry 9 of 33 File: USPT Nov 13, 2001

US-PAT-NO: 6316941
DOCUMENT-IDENTIFIER: US 6316941 B1

TITLE: Open view quadrature birdcage coil

DATE-ISSUED: November 13, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Fujita; Hiroyuki	Highland Heights	OH		
DeMeester; Gordon D.	Wickliffe	OH		
Braum; William O.	Twinsburg	OH		

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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10. Document ID: US 6288123 B1

L6: Entry 10 of 33 File: USPT Sep 11, 2001

US-PAT-NO: 6288123
DOCUMENT-IDENTIFIER: US 6288123 B1

TITLE: Therapeutic guanidines

DATE-ISSUED: September 11, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Goldin; Stanley M.	Lexington	MA		
Fischer; James B.	Cambridge	MA		
Knapp; Andrew Gannett	Salem	MA		
Reddy; N. Laxma	Malden	MA		
Berlove; David	Cambridge	MA		
Durant; Graham J.	Marshfield	MA		
Katragadda; Subbarao	Belmont	MA		
Hu; Lain-Yen	Bedford	MA		
Magar; Sharad	Somerville	MA		
Fan; Wenhong	Boston	MA		
Yost; Elizabeth	Waltham	MA		
Guo; Jun Qing	Waltham	MA		

US-CL-CURRENT: 514/634; 514/239.5, 514/247, 514/319, 514/325, 514/329, 514/415, 544/154, 544/155, 544/164, 544/230, 544/232, 544/294, 546/171, 546/203, 546/204, 546/205, 546/206, 546/223, 548/469, 564/230, 564/237, 564/238, 564/239

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 11. Document ID: US 6235309 B1

L6: Entry 11 of 33 File: USPT May 22, 2001

US-PAT-NO: 6235309
DOCUMENT-IDENTIFIER: US 6235309 B1

TITLE: Inhibition of cell-cell binding by lipid assemblies

DATE-ISSUED: May 22, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Nagy; Jon O.	Rodeo	CA		
Bargatze; Robert F.	Bozeman	MT		

US-CL-CURRENT: 424/450; 514/25, 514/42, 514/53, 514/54, 514/61

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 12. Document ID: US 6174924 B1

L6: Entry 12 of 33 File: USPT Jan 16, 2001

US-PAT-NO: 6174924
DOCUMENT-IDENTIFIER: US 6174924 B1

TITLE: Therapeutic guanidines

DATE-ISSUED: January 16, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Goldin; Stanley M.	Lexington	MA		
Fischer; James B.	Cambridge	MA		
Knapp; Andrew Gannett	Salem	MA		
Reddy; N. Laxma	Malden	MA		
Berlove; David	Cambridge	MA		
Durant; Graham J.	Cambridge	MA		
Katragadda; Subbarao	Belmont	MA		
Hu; Lain-Yen	Bedford	MA		
Magar; Sharad	Somerville	MA		
Fan; Wenhong	Rockey Hill	CT		
Yost; Elizabeth	Waltham	MA		
Guo; Jun Qing	Waltham	MA		

US-CL-CURRENT: 514/634; 514/239.5, 514/247, 514/319, 514/325, 514/329, 514/415, 544/154, 544/155, 544/164, 544/230, 544/232, 544/294, 546/171, 546/203, 546/204, 546/205, 546/206, 546/223, 548/469, 564/230, 564/237, 564/238, 564/239

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 13. Document ID: US 6165778 A

L6: Entry 13 of 33 File: USPT Dec 26, 2000

US-PAT-NO: 6165778
DOCUMENT-IDENTIFIER: US 6165778 A

TITLE: Reaction vessel agitation apparatus

DATE-ISSUED: December 26, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kedar; Haim	Palo Alto	CA		

US-CL-CURRENT: 435/289.1; 366/110, 366/111, 366/211, 422/104, 435/287.2

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 14. Document ID: US 6143791 A

L6: Entry 14 of 33 File: USPT Nov 7, 2000

US-PAT-NO: 6143791
DOCUMENT-IDENTIFIER: US 6143791 A

TITLE: Therapeutic guanidines

DATE-ISSUED: November 7, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Goldin; Stanley M.	Lexington	MA		
Fischer; James B.	Cambridge	MA		
Knapp; Andrew Gannett	Salem	MA		
Reddy; N. Laxma	Malden	MA		
Berlove; David	Cambridge	MA		
Durant; Graham J.	Marshfield	MA		
Katragadda; Subbarao	Belmont	MA		
Hu; Lain-Hu	Bedford	MA		
Magar; Sharad	Somerville	MA		
Fan; Wenhong	Rockey Hill	CT		
Yost; Elizabeth	Waltham	MA		
Guo; Jun Qing	Waltham	MA		

US-CL-CURRENT: 514/634; 514/239.5, 514/247, 514/319, 514/325, 514/329, 514/415, 544/154, 544/155, 544/164, 544/230, 544/232, 544/294, 546/171, 546/203, 546/204, 546/205, 546/206, 546/223, 548/469

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 15. Document ID: US 6081118 A

L6: Entry 15 of 33 File: USPT Jun 27, 2000

US-PAT-NO: 6081118
DOCUMENT-IDENTIFIER: US 6081118 A

TITLE: Rapid high-accuracy magnetic resonance imaging

DATE-ISSUED: June 27, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kaplan; Jerome I.	Indianapolis	IN	46205	

US-CL-CURRENT: 324/307; 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 16. Document ID: US 6029080 A

L6: Entry 16 of 33 File: USPT Feb 22, 2000

US-PAT-NO: 6029080
DOCUMENT-IDENTIFIER: US 6029080 A

TITLE: Method and apparatus for avian pre-hatch sex determination

DATE-ISSUED: February 22, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Reynnells; Richard D.	Laurel	MD	48864	
Flegal; Cal J.	Okemos	MI	20707	

US-CL-CURRENT: 600/407; 356/52, 356/55, 600/410, 600/437

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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17. Document ID: US 5919442 A

L6: Entry 17 of 33 File: USPT Jul 6, 1999

US-PAT-NO: 5919442
DOCUMENT-IDENTIFIER: US 5919442 A

TITLE: Hyper comb-branched polymer conjugates

DATE-ISSUED: July 6, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Yin; Rui	Midland	MI		
Tomalia; Donald A.	Midland	MI		
Hedstrand; David M.	Midland	MI		
Swanson; Douglas R.	Midland	MI		
Baker, Jr.; James R.	Ann Arbor	MI		
Kukowska-Latallo; Jolanta F.	Ann Arbor	MI		

US-CL-CURRENT: 424/78.18; 424/1.11, 424/1.33, 424/1.37, 424/178.1, 424/184.1, 424/193.1, 424/280.1, 424/405, 424/406, 424/422, 424/486, 424/487, 424/78.01, 424/78.19, 424/84, 424/85.1, 424/9.1, 424/DIG.16, 435/455, 514/44, 514/772, 525/417, 525/539, 525/902

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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18. Document ID: US 5773527 A

L6: Entry 18 of 33 File: USPT Jun 30, 1998

US-PAT-NO: 5773527
DOCUMENT-IDENTIFIER: US 5773527 A

TITLE: Non-crosslinked, polybranched polymers

DATE-ISSUED: June 30, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Tomalia; Donald A.	Midland	MI		
Hedstrand; David M.	Midland	MI		
Yin; Rui	Mount Pleasant	MI		

US-CL-CURRENT: 525/417; 525/374, 525/410, 525/411, 525/412, 528/363, 528/397,

528/403, 528/405

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 19. Document ID: US 5753477 A

L6: Entry 19 of 33 File: USPT May 19, 1998

US-PAT-NO: 5753477
DOCUMENT-IDENTIFIER: US 5753477 A

TITLE: Magneto-biolistic methods

DATE-ISSUED: May 19, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Chan; Daniel C.F.	Denver	CO		

US-CL-CURRENT: 435/455; 435/252.3, 435/252.33, 435/320.1, 435/325, 435/348, 435/351, 435/352, 435/410, 435/419, 435/420 , 435/431, 435/458, 435/459, 435/470

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 20. Document ID: US 5707875 A

L6: Entry 20 of 33 File: USPT Jan 13, 1998

US-PAT-NO: 5707875
DOCUMENT-IDENTIFIER: US 5707875 A

TITLE: 170-Labeled phosphoric acid compound and method and apparatus for selective observation of nuclear magnetic resonance signals using the compound

DATE-ISSUED: January 13, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Tamura; Mitsuru	Kawagoe			JP
Harada; Yoshinori	Saitama-ken			JP
Shimizu; Norio	Sayama			JP
Yasuda; Kenji	Saitama-ken			JP

US-CL-CURRENT: 436/173; 324/300, 324/307, 324/309, 324/322, 436/103, 436/105, 436/56, 600/420, 600/422, 600/431

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 21. Document ID: US 5655533 A

L6: Entry 21 of 33 File: USPT Aug 12, 1997

US-PAT-NO: 5655533
DOCUMENT-IDENTIFIER: US 5655533 A

TITLE: Actively shielded orthogonal gradient coils for wrist imaging

DATE-ISSUED: August 12, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Petropoulos; Labros	Cleveland Heights	OH		
Patrick; John L.	Chagrin Falls	OH		
Morich; Michael A.	Mentor	OH		

US-CL-CURRENT: 600/422; 324/318, 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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22. Document ID: US 5631329 A

L6: Entry 22 of 33 File: USPT May 20, 1997

US-PAT-NO: 5631329
DOCUMENT-IDENTIFIER: US 5631329 A

TITLE: Process for producing hyper-comb-branched polymers

DATE-ISSUED: May 20, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Yin; Rui	Mount Pleasant	MI		
Tomalia; Donald A.	Midland	MI		
Hedstrand; David M.	Midland	MI		
Swanson; Douglas R.	Midland	MI		

US-CL-CURRENT: 525/417; 525/279, 525/280, 525/326.8, 525/902, 525/91

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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23. Document ID: US 5629624 A

L6: Entry 23 of 33 File: USPT May 13, 1997

US-PAT-NO: 5629624
DOCUMENT-IDENTIFIER: US 5629624 A

TITLE: Switched field magnetic resonance imaging

DATE-ISSUED: May 13, 1997

INVENTOR-INFORMATION:

NAME.	CITY	STATE	ZIP CODE	COUNTRY
Carlson; Joseph W.	Kensington	CA		
Crooks; Lawrence E.	Richmond	CA		
Kaufman; Leon	San Francisco	CA		

US-CL-CURRENT: 324/309; 324/307

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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24. Document ID: US 5594337 A

L6: Entry 24 of 33 File: USPT Jan 14, 1997

US-PAT-NO: 5594337
DOCUMENT-IDENTIFIER: US 5594337 A

TITLE: Local coil for magnetic resonance angiography

DATE-ISSUED: January 14, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Boskamp; Eddy B.	Menomonee Falls	WI		

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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25. Document ID: US 5321014 A

L6: Entry 25 of 33 File: USPT Jun 14, 1994

US-PAT-NO: 5321014
DOCUMENT-IDENTIFIER: US 5321014 A

TITLE: Molecular encapsulation and delivery of alkenes alkynes and long chain alkanes, to living mammalian cells

DATE-ISSUED: June 14, 1994

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Janz; Siegfried	Bethesda	MD		
Shacter; Emily	Kensington	MD		

US-CL-CURRENT: 514/58; 435/29, 536/103

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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26. Document ID: US 5307015 A

L6: Entry 26 of 33 File: USPT Apr 26, 1994

US-PAT-NO: 5307015
DOCUMENT-IDENTIFIER: US 5307015 A

TITLE: NMR relaxometry using variable initial flip angle

DATE-ISSUED: April 26, 1994

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kaufman; Leon	San Francisco	CA		
Carlson; Joseph W.	Kensington	CA		

US-CL-CURRENT: 324/309; 324/307

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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27. Document ID: US 5281913 A

L6: Entry 27 of 33 File: USPT Jan 25, 1994

US-PAT-NO: 5281913
DOCUMENT-IDENTIFIER: US 5281913 A

TITLE: NMR relaxometry using fixed RF frequency band

DATE-ISSUED: January 25, 1994

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kaufman; Leon	San Francisco	CA		
Carlson; Joseph W.	Kensington	CA		

US-CL-CURRENT: 324/309; 324/300

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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28. Document ID: US 5221902 A

L6: Entry 28 of 33 File: USPT Jun 22, 1993

US-PAT-NO: 5221902
DOCUMENT-IDENTIFIER: US 5221902 A

TITLE: NMR neck coil with passive decoupling

DATE-ISSUED: June 22, 1993

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Jones; Randall W.	Mukwonago	WI		
Schubert; Thomas E.	Waukesha	WI		

US-CL-CURRENT: 600/422; 324/318, 600/415

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments   KWIC
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☐ 29. Document ID: US 5166618 A

L6: Entry 29 of 33   File: USPT   Nov 24, 1992

US-PAT-NO: 5166618
DOCUMENT-IDENTIFIER: US 5166618 A

TITLE: NMR neck coil with passive decoupling

DATE-ISSUED: November 24, 1992

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Jones; Randall W.	Mukwonago	WI		
Schubert; Thomas E.	Waukesha	WI		

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments   KWIC
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☐ 30. Document ID: US 5153517 A

L6: Entry 30 of 33   File: USPT   Oct 6, 1992

US-PAT-NO: 5153517
DOCUMENT-IDENTIFIER: US 5153517 A

TITLE: Surface resonator for a magnetic resonance imaging apparatus

DATE-ISSUED: October 6, 1992

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Oppelt; Ralph	Weiher			DE
Duerr; Wilhelm	Erlangen			DE
Siebold; Horst	Erlangen			DE

US-CL-CURRENT: 324/322; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments   KWIC
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31. Document ID: US 5146924 A

L6: Entry 31 of 33 File: USPT Sep 15, 1992

US-PAT-NO: 5146924
DOCUMENT-IDENTIFIER: US 5146924 A

TITLE: Arrangement for examination of a material

DATE-ISSUED: September 15, 1992

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sepponen; Raimo E.	Helsinki			FI

US-CL-CURRENT: 600/410; 324/309, 324/316, 600/411, 600/447

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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32. Document ID: US 5128615 A

L6: Entry 32 of 33 File: USPT Jul 7, 1992

US-PAT-NO: 5128615
DOCUMENT-IDENTIFIER: US 5128615 A

TITLE: Resonator for a magnetic resonance imaging apparatus

DATE-ISSUED: July 7, 1992

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Oppelt; Ralph	Weiher			DE
Duerr; Wilhelm	Erlangen			DE
Siebold; Horst	Erlangen			DE

US-CL-CURRENT: 324/322; 343/743

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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33. Document ID: US 4906931 A

L6: Entry 33 of 33 File: USPT Mar 6, 1990

US-PAT-NO: 4906931
DOCUMENT-IDENTIFIER: US 4906931 A

TITLE: Apparatus and method for the examination of properties of an object

DATE-ISSUED: March 6, 1990

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sepponen; Raimo	Helsinki			FI

US-CL-CURRENT: 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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Term	Documents
(3 NOT 5).USPT,PGPB,JPAB,EPAB,DWPI,TDBD.	33
(L3 NOT L5).USPT,PGPB,JPAB,EPAB,DWPI,TDBD.	33

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DOCUMENT-IDENTIFIER: US 5655533 A
TITLE: Actively shielded orthogonal gradient coils for wrist imaging

Abstract Text (1):
A magnetic resonance imaging apparatus includes main field coils (10) for generating a temporally uniform magnetic field longitudinally through a central bore (12). A whole body gradient magnetic field coil (30) and radio frequency coil (36) are disposed around the bore. An insertable coil assembly (40) includes an insertable gradient coil, a radio frequency coil (74) and a radio frequency shield (76). The insertable gradient coil includes a pair (62, 64) of x-gradient windings (FIGS. 3 and 4), a pair (66, 68) of y-gradient windings (FIGS. 5 and 6), and a pair (70, 72) of z-gradient windings (FIGS. 7 and 8), which are wrapped around inner and outer surfaces of a dielectric former (60). The x, y, and z insertable gradient coil pairs are configured such that they generate uniform magnetic field gradients within the insertable coil assembly when its central axis is positioned transverse to the direction of the temporally uniform magnetic field generated by the main field coils. The insertable coil assembly is ideally suited for imaging a patient's wrist when the patient rests the insertable coil assembly with its wrist therein on the patient's thorax region transverse to the central bore of the magnetic resonance imaging apparatus.

Brief Summary Text (2):
The present invention relates to the magnetic resonance imaging art. It finds particular application in conjunction with insertable gradient coils for imaging the wrist and will be described with particular reference thereto. However, it is to be appreciated that the invention will also find application in conjunction with other types of insertable magnetic field gradient coils.

Brief Summary Text (3):
Magnetic resonance imagers commonly include a large diameter, whole body gradient coil which surrounds a patient receiving bore. Main field magnets, either superconducting or resistive, and radio frequency transmission/reception coils also surround the bore. Although the whole body gradient coils produce excellent linear magnetic field gradients, they have several drawbacks. With large diameter gradient coils, the slew rate is sufficiently slow that it is a limiting factor on the rate at which gradient magnetic fields can be induced and changed. Large diameter whole body gradient coils have relatively low gradient field per unit Ampere for given inductance which limits their use for some of the highest speed magnetic resonance imaging techniques. The energy stored in gradient coils is generally proportional to more than the fifth power of the radius. Hence, large diameter, whole body coils require much larger amounts of energy. Further, superconducting main magnets have cold shields disposed around the bore. The larger the diameter of the gradient coil, the closer it is to the cold shields and, hence, the more apt it is to produce eddy currents. More shielding is needed to prevent the whole body gradient coils from inducing eddy currents in the cold shields than would be necessary for smaller diameter coils.

Brief Summary Text (6):
In conventional whole body magnetic resonance imagers, the main magnetic field aligns axially with a central bore of a superconducting magnet assembly. The central bore is typically about 60 cm in diameter, and about 2 m in length. Part of the bore is lost to the patient supporting couch and other associated equipment. Moreover, it is advantageous for the patient to be generally centered in the bore. If the patient is pressed against the bore, the patient may be so close to the surrounding gradient and RF coils that artifacts are induced in the resultant image. With these

constraints, it is very difficult to position a patient comfortably in the bore with his/her wrist at the isocenter and with the central axes of the wrist coil and the main magnet bore aligned.

Drawing Description Text (3):
FIG. 1 is a diagrammatic illustration of a magnetic resonance imaging system including an insertable wrist coil in accordance with the present invention;

Detailed Description Text (5):
An operator interface and control station 50 includes a human-readable display such as a video monitor 52 and an operator input means including a keyboard 54 and a mouse 56. A computer control and reconstruction module 58 includes computer hardware and software for controlling the radio frequency coils 36 and 46 and the gradient coils 30 and 44 to implement any of a multiplicity of conventional magnetic resonance imaging sequences, including echo-planar and echo-volume imaging sequences. Echo-planar imaging and echo-volume imaging sequences are characterized by short repetition rates and low flip angles. The processor 58 also includes a digital transmitter for providing RF excitation and resonance manipulation signals to the RF coils and a digital receiver for receiving and demodulating magnetic resonance signals. An array processor and associated software reconstruct the received magnetic resonance signals into an image representation which is stored in computer memory or on disk. A video processor selectively extracts portions of the stored reconstructed image representation and formats the data for display by the video monitor 52.

Detailed Description Text (6):
With reference to FIG. 2, the active gradient insertable wrist coil 40 includes an insertable gradient coil assembly. A cylindrical, dielectric former 60 supports an inner x-gradient coil 62 of radius a and an outer x-gradient coil 64 of radius b. The inner gradient coil is of length L. The former further supports an inner y-gradient coil 66 of radius a and length L and an outer y-gradient coil of radius b. The former further supports an inner z-gradient coil 70 of radius a and length L and an outer z-gradient coil 72 of radius b. The inner and outer x, y, and z-gradient coils may be encased in epoxy resin to become unitary with the former, but are preferably built on two or more discrete formers to provide cooling passages between the inner and outer gradient coils. An insertable RF coil 74 is mounted inside the dielectric former. An RF shield 76 is mounted between the insertable RF and gradient coils. The RF coil is preferably solenoidal in geometry to produce a B.sub.1 field orthogonal to B.sub.0, where the axis of the solenoid is aligned with the wrist gradient cylindrical axis. A Helmholtz pair is preferred. A vertical mode birdcage or saddle coil can be used as an alternative to, or in conjunction with the Helmholtz pair to give a quadrature RF configuration.

Detailed Description Text (9):
In the preferred embodiment of the x wrist gradient coil, the radius a of the inner coil is 7 cm and the radius b of the outer coil is 8.5 cm and the total inner coil length L is 20 cm. The sizes are chosen in order to fit in the region between the thorax and a plastic cover of the magnetic resonance imager.

Detailed Description Text (10):
The discrete winding patterns for both the inner or primary coil and outer or secondary coil which correspond to a 40 mT/m gradient strength with a 5% on-axis linearity and a 5% off-axis uniformity for a 10 cm in diameter spherical volume are illustrated in FIGS. 3 and 4. The primary x-gradient coil 62 has a generally figure-8 configuration. The x-gradient shield coil 64 has counter rotating current loops centrally with outer loops.

Detailed Description Text (17):
In the preferred embodiment, the radius of the inner coil is 7 cm and its length is 20 cm. The radius of the outer z-gradient coil is 8.5 cm. For a 44 mT/m gradient strength with a 2.5% on-axis linearity and a 2.5% off-axis uniformity, the discrete winding patterns of the z-gradient coil are illustrated in FIGS. 7 and 8. The primary z-gradient coils 70 include counter rotating current loops with linearity improving central loops. The z-gradient shield coils 72 include counter rotating current loops.

CLAIMS:

1. In a magnetic resonance imaging apparatus which includes a means for generating a

temporally uniform magnetic field along a primary magnetic field axis through an examination region, a means for transmitting radio frequency signals into the examination region for inducing and manipulating magnetic resonance of dipoles disposed in the examination region, and a means for receiving magnetic resonance signals emanating from the selected portion of the subject and reconstructing the received magnetic resonance signals into an image representation, the improvement comprising:

a dielectric cylinder having a tubular side wall that extends parallel to and surrounds a longitudinal central axis of the dielectric cylinder;

a gradient coil assembly mounted on and extending around the dielectric cylinder, the dielectric cylinder and the gradient coil assembly being removably disposed in the examination region with said longitudinal central axis of the dielectric cylinder oriented transverse to the primary magnetic field axis.

2. A magnetic resonance imaging apparatus comprising:

a main magnetic field means for generating a temporally constant magnetic field along a magnetic field axis through a central bore thereof;

a radio frequency coil means for at least transmitting radio frequency signals into the central bore for inducing and manipulating magnetic resonance of selected dipoles in the bore;

a means for receiving magnetic resonance signals emanating from the selected dipoles in the bore and reconstructing an image representation from the magnetic resonance signals; and,

a magnetic field gradient coil assembly dimensioned to receive a portion of a subject along a subject axis thereof, the magnetic field gradient coil assembly being removably disposed within the bore with the subject axis out of alignment with the magnetic field axis, the magnetic field gradient coil assembly including gradient coil means for generating magnetic field gradients along three orthogonal axes across the portion of the subject received in the magnetic field gradient coil assembly.

3. The magnetic resonance imaging apparatus as set forth in claim 2 wherein the main magnetic field has a first component parallel to the bore and at least a second component in a direction transverse to the bore and wherein the magnetic field gradient coil assembly includes a first gradient coil means for generating a gradient field along the second component, which generated gradient field is anti-symmetric in the second component direction and symmetric parallel to the bore.

4. The magnetic resonance imaging apparatus as set forth in claim 3 wherein the magnetic field gradient coil assembly further includes a second gradient coil means for generating a magnetic field gradient along a direction orthogonal to the first component and the second component direction.

5. The magnetic resonance imaging apparatus as set forth in claim 4 wherein the magnetic field gradient coil assembly includes a third gradient coil means which carries a current density that is odd-symmetric around the first component and symmetric around the second component direction.

6. The magnetic resonance imaging apparatus as set forth in claim 2 wherein the main magnetic field has a first component parallel to the bore and at least a second component transverse to the bore and wherein the magnetic field gradient coil assembly includes a first gradient coil pair means for interacting cooperatively to create a first gradient field within the gradient coil assembly which is even-symmetric in a direction parallel to the second component and symmetric in a direction parallel to the bore.

7. The magnetic resonance imaging apparatus as set forth in claim 6 wherein the magnetic field gradient coil assembly further includes a second gradient coil pair means for interacting cooperatively to generate a second gradient field with the gradient coil assembly along a direction orthogonal to the bore and the second component.

8. The magnetic resonance imaging apparatus as set forth in claim 7 wherein the magnetic field gradient coil assembly includes a third gradient coil pair means for interacting cooperatively to carry a current density that is odd-symmetric around a direction parallel to the bore and symmetric around a direction parallel to the second component.

9. A magnetic resonance imager apparatus comprising:

a main field magnet which generates a temporally constant magnetic field along a magnetic field axis through a central bore thereof;

a radio frequency coil connected with a radio frequency transmitter and positioned to transmit radio frequency signals from the transmitter into the central bore;

a receiver connected to the radio frequency coil to receive magnetic resonance signals emanating from the selected dipoles in the bore;

a reconstruction processor which reconstruct an image representation from the magnetic resonance signals; and,

a magnetic field gradient coil assembly dimensioned to receive a portion of a subject along a subject axis thereof, the magnetic field gradient coil assembly being removably disposed in the bore with the subject axis orthogonal to the magnetic field axis, the magnetic field gradient coil assembly including gradient coils that convert received current pulses into magnetic field gradients along three orthogonal axes across the portion of the subject received in the magnetic field gradient coil assembly.

10. A magnetic resonance imaging apparatus comprising:

a main field magnet having a central bore through which a temporally constant magnetic field extends along a magnetic field axis;

a radio frequency coil disposed adjacent the central bore;

an image processor connected with the radio frequency coil;

a magnetic field gradient coil assembly dimensioned to receive a portion of a subject along a subject axis thereof, the magnetic field gradient coil assembly being removably disposed within the central bore with the subject axis out of alignment with the magnetic field axis, the magnetic field gradient coil assembly includes:

a cylindrical dielectric former;

a pair of z-gradient coils of different radii from each other supported by the dielectric former, the pair of z-gradient coils being positioned such that received current pulses cause magnetic field gradients within an internal bore of the dielectric former along a z-axis;

a pair of y-gradient coils of different radii from each other supported by the dielectric former, the pair of y-gradient coils being positioned such that received current pulses cause magnetic field gradients within the internal bore of the dielectric former along a y-axis, where the z and y axes are orthogonal to each other;

a pair of x-gradient coils of different radii from each other supported by the dielectric former, the pair of x-gradient coils being positioned such that received current pulses cause magnetic field gradients within the internal bore of the dielectric former along an x-axis, where the x-axis is orthogonal to the y and z-axes.

11. The magnetic resonance imaging apparatus as set forth in claim 10 wherein the cylindrical dielectric former is disposed in the main magnetic field with the dielectric former internal bore perpendicular to the magnetic field axis.

12. The magnetic resonance imaging apparatus as set forth in claim 10 wherein the x-gradient coil pair includes two individual x-gradient coils which are mounted on the dielectric former on opposite sides thereof, the individual x-gradient coils

each being generally figure-8 shaped.

13. The magnetic resonance imaging apparatus as set forth in claim 12 wherein the y-gradient coil pair includes two individual y-gradient coils mounted along opposite sides of the dielectric former and 90.degree. rotated from the two individual x-gradient coils, the individual y-gradient coils each including at least one current loop.

14. The magnetic resonance imaging apparatus as set forth in claim 13 wherein at least one of the individual y-gradient coil includes three current loops generally aligned along a common axis which is parallel to an axis of the dielectric former internal bore.

15. The magnetic resonance imaging apparatus as set forth in claim 13 wherein the pair of z-gradient coils includes two individual z-gradient coils disposed on opposite sides of the dielectric former and having a central axis which is substantially aligned with the common axis of the individual y-gradient coil loops.

16. The magnetic resonance imaging apparatus as set forth in claim 10 further including an insertable radio frequency coil mounted within the cylindrical dielectric former and a radio frequency shield disposed between the insertable radio frequency coil and the x, y, and z-gradient coil pairs.

17. A magnetic resonance imaging method comprising:

generating a temporally constant magnetic field along a magnetic field axis through an imaging region;

transmitting radio frequency signals into the imaging region to induce and manipulate magnetic resonance of selected dipoles in the imaging region;

receiving magnetic resonance signals emanating from the selected dipoles in the imaging region and reconstructing an image representation from the magnetic resonance signals; and,

receiving a portion of a subject along a subject receiving axis of a magnetic field gradient coil assembly;

disposing the subject and the magnetic field gradient coil assembly in the imaging region with the subject receiving axis out of alignment with the magnetic field axis;

with the magnetic field gradient coil assembly, generating magnetic field gradients along three orthogonal axes across the portion of the subject receiving in the magnetic field gradient coil assembly.

DOCUMENT-IDENTIFIER: US 5594337 A
TITLE: Local coil for magnetic resonance angiography

Brief Summary Text (3):
The field of the invention is magnetic resonance imaging (MRI) and, in particular, local coils for use in magnetic resonance angiography (MRA).

Brief Summary Text (5):
A. MRI Imaging

Brief Summary Text (6):
In MRI, a uniform magnetic field B.sub.0 is applied to an imaged object along the z-axis of a Cartesian coordinate system, the origin of which is approximately centered within the imaged object. The effect of the magnetic field B.sub.0 is to align the object's nuclear spins along the z-axis.

Brief Summary Text (8):
where .omega. is the Larmor frequency, and .gamma. is the gyromagnetic ratio which is a constant and a property of the particular nuclei. The component of the nuclear spins aligned with the x-y plane is termed the transverse magnetization. The rate of decay of the transverse magnetization differs for different tissues and hence may be used to distinguish among tissue in an MRI image.

Brief Summary Text (12):
A weak nuclear magnetic resonance generated by the precessing nuclei may be sensed by the RF coil and recorded as an NMR signal. From this NMR signal, a slice image may be derived according to well known reconstruction techniques. An overview of NMR image reconstruction is contained in the book "Magnetic Resonance Imaging, Principles and Applications" by D. N. Kean and M. A. Smith.

Brief Summary Text (14):
The time between the RF excitation and the recording of the NMR data may be used to detect and measure the flow of blood in blood vessels and thereby to detect obstructions and to distinguish the blood vessels from stationary tissue as demarcated by the flowing blood.

Brief Summary Text (17):
The quality of the image produced by MRI techniques is dependent, in part, on the strength of the NMR signal received from the precessing nuclei. For this reason, it is known to use an independent RF receiving coil placed in close proximity to the region of interest of the imaged object in order to improve the strength of this received signal. Such coils are termed "local coils" or "surface coils" The smaller area of the local coil permits it to accurately focus on NMR signals from the region of interest. Further, the RF energy of the field of such a local coil is concentrated in a smaller volume giving rise to improved signal-to-noise ratio in the acquired NMR signal.

Brief Summary Text (18):
The signal-to-noise ratio of the NMR signal may be further increased by employing a coil that is sensitive to RF energy along both of a pair of mutually perpendicular axes. This technique is generally known as quadrature detection and the signals collected are termed quadrature signals.

Brief Summary Text (20):
The quadrature orientation of the two coils introduces a 90.degree. phase difference

between the NMR signals detected by these coils. Therefore, combining the outputs from the two quadrature coils, to achieve the above described signal-to-noise ratio improvement, requires that one signal be shifted to have the same phase as the other signal so that the amplitudes of the signals simply add.

Brief Summary Text (22):
As used herein, the term quadrature coil and quadrature signal, will refer to the detecting of the NMR signal along multiple axes and combining the signals so collected, with the appropriate phase shifts to produce a signal of improved signal-to-noise ratio.

Brief Summary Text (28):
Specifically, the coil includes a base sized to fit against the table of an MRI machine and extending a longitudinal axis. A cover unit opposes the base and is positioned above the base to define an imaging volume between itself and the base. A number of first coils are attached to the base and the cover each having a reception pattern of a first orientation within the imaging volume. Second coils are attached to the base and cover opposed in a substantially symmetrical fashion to the first coils about the imaging volume. The second coils have at least one diametric conductor dividing each second coil into a pair of loops having a second reception pattern within the imaging volume at a second orientation substantially 90.degree. in separation from the orientation. The first and second coils are alternated along the longitudinal axis on the base and cover.

Brief Summary Text (34):
In a second embodiment, the coil structure includes a base sized to fit against an MRI table and extending along a longitudinal axis. An upstanding divider extends vertically from the base and horizontally along the longitudinal axis and is positioned and sized to fit between and align the legs of the patient when the patient is lying on the base. An NMR receiving antenna is attached to and supported by the base and the upstanding divider.

Brief Summary Text (35):
A cover unit may be attached to the top of the upstanding divider and the NMR antenna may also be supported by the cover unit. Alternatively, a first and second upstanding flanking rail may be attached to the transverse edges of the base and the NMR antenna may also be supported by the upstanding flanking rails.

Brief Summary Text (37):
The NMR antenna may include a first loop conductor supported by the cover attached to the upstanding divider and having a gap at a first side. A second loop conductor may be supported by the base and may also have a gap, the ends of the gaps of the first and second loop conductors being joined by first and second conductors passing through the upstanding divider. A third conductor passing through the upstanding divider may join the first loop conductor and the second loop conductor between points opposed to their respective gaps.

Brief Summary Text (39):
Alternatively, the NMR antenna may employ a first loop conductor supported by the first upstanding flanking rail and having a gap at its bottom and a second loop conductor supported by the second upstanding flanking rail also having a gap at its bottom. A first and second conductor passing through the base joined the gaps. A third loop conductor, unconnected to the first and second loop conductors, is positioned within the divider between the first and second loop conductors.

Brief Summary Text (41):
The coil may include a co-planar shelf portion attached to one longitudinal end of the base and having a second NMR antenna supported by the shelf portion with a region of sensitivity encompassing the lower pelvis of the patient when the patient is supine on the base with the patient's legs straddling the upstanding divider. The first NMR antenna may include a plurality of reception coils spaced along the longitudinal axis. A switch alternately connects different subsets of the reception coils between an output cable to the MRI machine and isolation circuits so that a piecewise image of the entire length of the legs of the patient may be obtained.

Drawing Description Text (12):
FIGS. 11 and 12 are detailed perspective views of the overlapping coil elements of FIG. 9 showing two modes of resonance which provide for quadrature detection of NMR signals in the legs;

Detailed Description Text (2):
Referring to FIGS. 1 and 3, angiographic coil 10 of the present invention includes a generally planar base 12 positioned horizontally to fit on the upper surface of the table 15 of the magnetic resonance imaging machine (not shown). Curved ribs 14 are attached to the under surface of the base 12 to support the planar base 12 against the curved upper surface of the table 15. The base 12 extends transversely by the width of the table 15 and extends longitudinally by a distance suitable to support the entire length of the leg of an average patient 16 when the patient 16 is supine on the base 12 with legs extending longitudinally along the base 120 Coplanar with the base 12 and extending from one longitudinal end of the base 12 is a shelf 18 which serves to support the pelvic region of the patient 16 when the patient 16 is supine as described. The upper surface of the base 12 and shelf 18 may be covered by a thin foam cushion (not shown).

Detailed Description Text (17):
Capacitors 46 are placed in series with these conductors 44 at the midpoints of these two parallel conductors 44 so as to produce a resonant mode in the coil 36 in which current flows clockwise through loop 40 when it is flowing in a counterclockwise direction in loop 42 and vice versa. The effect of this mode is that each rectangular loop 40 and 42 will be sensitive to changes in the transverse magnetization component of the NMR signal from spins near the respective loop 40 or 42. There will be no sensitivity near a plane midway between loops 40 and 42 where the equal but opposite polarity of the loops 40 and 42 will result in a cancellation of any induced current flow.

Detailed Description Text (22):
Referring now to FIG. 6, the total of twelve signals from the coils 30 passing over cables 31 are selectively switched by switch 50 to four preamplifiers 52 forming an input to the signal processing circuitry of a standard MRI system. To produce an image, signals 1 and 2 and 3 and 4 are received by the switch 50 and routed separately to one of the four preamplifiers 52. After completion of the data acquisition of signals 1, 2, 3 and 4, the switch 50 is moved so as to obtain data from coils 5, 6, 7 and 8.

Detailed Description Text (23):
Another image acquisition sequence is performed and the switch is again advanced to obtain the signals from coils 9, 10, 11 and 12 and forward those to preamplifiers 52. Three separate imaging sequences thus are performed to produce three images which may be combined according to methods well known in the art to provide a complete picture of blood flow within the legs and lower pelvic region of the patient 16. In the preferred embodiment, the signals received from the preamplifiers 52 are combined after image reconstruction in the MRI system.

Detailed Description Text (25):
In particular, where the signal is taken across a capacitor 56, an inductance 58 is selected to be inserted in one of the conductors 57 going to the differential inputs of the preamplifier 52 so that the inductance 58 together with the impedance of the preamplifier 52 (the series combination of which shunts capacitor 56) is such as to provide parallel resonance in the loop of coil 30 blocking current flow at the NMR frequency. Generally, the magnitude of the impedance shunting capacitor 56 will be a combination of the inductance 58 and the input impedance of the preamplifier 52 as transformed by the connecting cable. Importantly, for such isolation to occur when a given coil group of 38 and 36 is not connected to a preamplifier 52, that coil group must be connected to a load 54 having a similar impedance as that of the preamplifier 52. Thus, dummy loads 54 approximating the input impedance of the preamplifiers 52 are connected to the signals not received by the preamplifiers 52.

Detailed Description Text (29):
The resulting coil 63 operates in two resonant modes. In the first mode shown in FIG. 11, currents flowing through loops 60 and 62 and thus through capacitor 66 are co-cyclic to provide a vertical axis of sensitivity per conventional solenoid-type designs. In the second mode shown in FIG. 12, currents do not flow around loop 60 and 62 but instead flow through capacitor 68 and in the opposite direction through both of conductors 64 so as to create equal current flows in both longitudinal edges of loop 60 in a first direction and equal current flows through both longitudinal edges of loop 62 in the opposite direction. The net effect is to create an effective horizontal solenoid and thus a sensitivity to changes in magnetic flux in a horizontal transverse direction.

Detailed Description Text (36):
Referring now to FIGS. 8 and 9, the coils of FIGS. 11 and 12 are augmented by a coil on the shelf 18 and within the cover 72 above the shelf to image the pelvic region. This coil may be the pelvic coil 32 previously described or may be a coil 33 (serving a similar function to pelvic coil 32 previously described) consisting of a pair of coils 33A and 33B each having two overlapping rectangular loops generally conforming to and supported by the planar area of the shelf 18 or the cover 72, respectively, and having separate leads for transmitting their received signals. The sides of the loops are generally parallel to the adjacent edges of the shelf 18, each loop of coil 33A or 33B occupying only slightly more than half the area of the shelf 18 or corresponding area of the cover 72 so as to overlap along the central longitudinal axis of the shelf 18 or cover 72. Coils 33 provides coverage of NMR signals in the region of the patient's lower pelvis. The signals 1 and 2 are taken across one of the capacitances that tune the loops of coil 33A into resonance. The signals 3 and 4 are taken across one of the capacitances that tune the loops of coil 33B into resonance.

Detailed Description Text (40):
During imaging, a connector 100 for one of the cables 31(a) through 31(c) is connected to the MRI machine (not shown) and the other two cables 31 are connected to terminator blocks providing dummy loads 54 attached to the upper surface of the base 12 near the patient's feet to provide the termination function previously described.

Detailed Description Text (46):
As is well known in the art, each loop of the above described coils is broken at regular intervals around its circumference by capacitances (not shown) so that the combined series inductance of the conductors of the coils and capacitance so inserted makes the coils resonant at the NMR frequency for the given magnetic resonance imaging system.

Detailed Description Text (47):
Each coil also includes passive decoupling (not shown) as is well known in the art, which decouples the loop from the initial high energy RF excitation field but allows it to couple to the subsequent lower NMR signal to be detected. Examples of the detailed electrical structure of such loops including passive decoupling networks suitable for use with the present invention are described in U.S. Pat. No. 5,136,244 issued Aug. 4, 1992, assigned to the same assignee as the present invention and hereby incorporated by reference.

Detailed Description Text (48):
Referring now to FIG. 18, in another embodiment of the angiographic coil 150, the coils are supported on a semi-cylindrical base 152 and semi-cylindrical cover 154 having concave inner surfaces receiving, respectively, the posterior and anterior surfaces of the lower pelvis and legs of the patient 16 (not shown). The lower surface of the base 152 generally conforms to the upper surface of the MRI table to provide a rigid support for the base 152.

Detailed Description Text (51):
The two loop coil 162 may also be generally rectangular in outside dimension but is bifurcated by a single conductor 164 extending longitudinally across the center of the coil 162 to produce two loops having a shared wall of that conductor 164. Coil 162 is tuned, at resonance, to a mode having counter-rotating currents in each of the two loops such currents adding in the center conductor 164 where the coils signal is obtained.

Detailed Description Text (56):
These signals are carried by cables 168 similar to cables 31 as have been previously described to the MRI equipment, however the conductors 168 carry half the number of signals as the cables 31 by virtue of the electrical independence of the cover 154 and base 152. Terminating blocks 54 are attached to both the cover 154 and base 152 so that those cables 168 not being used to carry signals to the MRI machine may be properly terminated as described above with respect to FIGS. 6 and 7.

Detailed Description Text (57):
Referring now to FIGS. 19 and 20, coils 160 and 162 which are placed in opposed configuration on the base 152 and the cover 154, are sensitive to the NMR signal along different axes. Specifically, coils 160 are generally sensitive to magnetic

flux along a vertical axis perpendicular to the longitudinal axis 158 whereas the two loop coil 162 is generally sensitive to magnetic flux along the longitudinal axis 158. As a result, coils 160 and 162 when opposed to each other on the base 152 and cover 154, are isolated with respect to mutual inductance and provide signals, which when combined, produce a signal-to-noise improvement over either coil 160 or 164 alone. As shown in FIG. 19, magnetic flux generated by countervailing currents in two loop coil 162 pass symmetrically in both directions through opposed coil 160 generating no net current flow. Likewise, flux generated by a circulating current in single loop coil 160, shown in FIG. 20, produces similar fluxes in the two loops of dual loop coil 162 thereby also generating no net current flow in the center conductor 164.

Detailed Description Text (60):
Coils suitable for use with this embodiment are described in detail in the parent application Ser. No. 08/057,939 filed May 7, 1993 and entitled Two Part Quadrature NMR Coil, assigned to the assignee of this application and hereby incorporated by reference.

CLAIMS:

1. An MRI coil for angiographic imaging of the lower-trunk and legs comprising:

a base sized to fit against a table of an MRI machine and extending along a longitudinal axis;

a cover unit opposing the base and positionable above the base, together with the base to define an imaging volume therebetween;

a plurality of first coils attached to the base and cover and having first reception patterns which couple to RF magnetic fields of a first orientation within the imaging volume to produce first signals; and

a plurality of second coils attached to the base and cover and opposed substantially symmetrically to the first coils about the imaging volume, the second coils having at least one diametric conductor to divide each second coil into a pair of loops, the second coils having second reception patterns which couple to RF magnetic fields of a second orientation within the imaging volume to produce second signals, the second orientation having an angular separation from the first orientation of substantially 90 degrees;

wherein the first and second coils are alternated along the longitudinal axis.

2. The MRI coil of claim 1 wherein the cover includes an aperture located on the cover at a position above a patient's feet when the patient's lower trunk and legs are positioned within the imaging volume and wherein the first coil is a single loop surrounding the aperture permitting toes of the patient's feet to extend through the aperture.

3. The MRI coil of claim 1 wherein base and cover are cylindrically concave about the imaging volume.

4. The MRI coil of claim 1 wherein the cover and base are sized so as to be self-supporting against the patient and including flexible straps attached to at least one of the cover and base to draw the cover and base toward each other about the patient.

5. An MRI coil for angiographic imaging of the lower trunk and legs compromising:

a base sized to fit against a table of an MRI machine and extending along a longitudinal axis;

an upstanding divider extending vertically from the base and horizontally along the longitudinal axis, the divider being sized so as to fit between and align the legs of a supine patient lying on the base;

an NMR receiving antenna having a region of sensitivity encompassing both legs of the patient when the patient is supine on the base with the patient's legs straddling the upstanding divider;

a cover unit attached to the top of the upstanding divider to oppose the base and wherein the NMR antenna is supported by the base, the upstanding divider, and cover unit; and

wherein the upstanding divider detaches from one of the base and cover and wherein the NMR antenna includes electrical connectors to permit separation of the portions of the NMR antenna supported by the cover from the portions supported by the base to permit separation of the base and cover for ingress and egress by the patient.

6. The MRI coil of claim 5 wherein the NMR antenna comprises:

a first loop conductor supported by the cover having four sides, the first loop conductor having a first gap at the first side, the ends of the loop at the gap forming a first and second terminal;

a second loop conductor supported by the base and opposed to the first loop conductor about an imaging volume, the second loop conductor having a second gap at the first side, the ends of the second loop at the gap forming a third and fourth terminal;

a first conductor supported by the divider joining the first terminal to the third terminal;

a second conductor supported by the divider joining the second terminal to the third terminal;

a third conductor supported by the divider joining the first loop conductor at a point diametrically opposed to the first gap, to the second loop conductor at a point diametrically opposed to the second gap;

wherein in a first resonant mode current flows in the same direction in the second sides of the first and second coils and current flows in the same direction in the fourth sides of the first and second coils to be sensitive to changing magnetic vector along a substantially vertical axis; and

wherein, in a second resonant mode, current flows in the opposite direction in the second sides of the first and second coils and current flows in the opposite direction in the fourth sides of the first and second coils to be sensitive to changing magnetic vector along a substantially horizontal axis.

7. The MRI coil of claim 5 including a coplanar shelf portion is attached to one longitudinal end of the base and including a second NMR antenna supported by the shelf portion to have a region of sensitivity encompassing the lower pelvis of the patient when the patient is supine on the base with the patient's legs straddling the upstanding divider.

8. The MRI coil of claim 7 including a third NMR antenna positioned opposite the second NMR antenna about the lower pelvis of the patient when the patient is supine on the base with the patient's legs straddling the upstanding divider.

9. The MRI coil of claim 5 wherein the NMR antenna includes a plurality of reception coils spaced along the longitudinal axis and including a switch alternately connecting different subsets of the reception coils between an output cable so that a piecewise image of the entire length of the legs of a patient may be obtained for a patient supine on the base with the patient's legs straddling the upstanding divider.

10. An MRI coil for angiographic imaging of the lower trunk and legs comprising:

a base sized to fit against a table of an MRI machine and extending along a longitudinal axis;

an upstanding divider extending vertically from the base and horizontally along the longitudinal axis, the divider being sized so as to fit between and align the legs of a supine patient lying on the base;

an NMR receiving antenna supported by the base and divider to have a region of sensitivity encompassing both legs of a patient when a patient is supine on the base with the patients legs straddling the upstanding divider; and

first and second upstanding flanking rails attached to transverse edges of the central portion of the base wherein the NMR antenna is supported by the base, the upstanding divider and the first and second upstanding flanking rails.

11. The MRI coil of claim 10 wherein the first and second upstanding flanking rails are attached to the transverse edges of the base by hinges having longitudinal hinge axes so that the first and second upstanding flanking rails may be folded horizontally outward for patient axes and wherein the NMR antenna includes flexible conductor portions to permit flexure of the NMR antenna as it passes between the base and the first and second upstanding flanking rails to permit easy access by a patient.

12. The MRI coil of claim 10 wherein the first and second upstanding flanking rails are constructed of flexible material and where the NMR antenna as supported by the first and second upstanding rails is flexible so that the first and second upstanding flanking rails may be folded horizontally outward for patient access and including rigid support poles that may be inserted and removed from the base to hold the first and second flanking rails in an upstanding position when inserted in the base.

13. The MRI coil of claim 10 wherein the first and second upstanding flanking rails are constructed of flexible material and where the NMR antenna as supported by the first and second upstanding rails is flexible so that the first and second upstanding flanking rails may be folded horizontally outward for patient access and including rigid support shell that may be placed over the patient on the base to hold the first and second flanking rails in a predetermined configuration when the first and second flanking rails are folded against the shell.

14. The MRI coil of claim 10 wherein the NMR antenna comprises:

a first loop conductor supported by the first upstanding flanking rail and having four sides, the first loop conductor having a first gap at the first side, the ends of the loop at the gap forming a first and second terminal;

a second loop conductor supported by the second upstanding flanking rail opposed to the first loop conductor about an imaging volume, the second loop conductor having a second gap at the first side, the ends of the second loop at the gap forming a third and fourth terminal;

a first conductor supported by the base joining the first terminal to the third terminal;

a second conductor supported by the base joining the second terminal to the third terminal; and

a third loop conductor supported by the upstanding divider and positioned between the first and second loop conductors in opposition to the first and second loop conductors to bifurcate the imaging volume;

wherein in the first and second loops have a resonant mode sensitive to changing magnetic vector along a substantially vertical axis; and

wherein the third loop conductor has a resonant mode sensitive to a changing magnetic vector along a substantially horizontal axis.

15. An MRI quadrature coil comprising:

a first loop conductor having consecutive, first, second, third and fourth sides the first loop conductor having a first gap at the first side, the ends of the loop at the gap forming a first and second terminal;

a second loop conductor opposed to the first loop conductor about an imaging volume also having consecutive first, second, third and fourth sides, the second loop conductor having a second gap at the first side, the ends of the second gap forming a third and a fourth terminal;

a first conductor joining the first terminal to the third terminal;

a second conductor joining the second terminal to the fourth terminal;

a third conductor joining the first loop conductor at a point diametrically opposed to the first gap, to the second loop conductor at a point diametrically opposed to the second gap;

wherein, in a first resonant mode, current flows in the same direction in the second sides of the first and second coils and current flows in the same direction in the fourth sides of the first and second coils to be sensitive to changing magnetic vector along a first axis; and

wherein, in a second resonant mode, current flows in the opposite direction in the second sides of the first and second coils and current flows in the opposite direction in the fourth sides of the first and second coils to be sensitive to changing magnetic vector along a second axis substantially perpendicular to the first axis.

16. The MRI quadrature coil of claim 15 including a first capacitor joining the midpoints of the first and second conductors across which a signal indicating the changing magnetic vector along the first axis may be developed and including a second capacitor breaking the midpoint of the third conductor across which a signal indicating the changing magnetic vector along the second axis may be developed.

17. The MRI quadrature coil of claim 15 wherein the first and second loop are substantially planar and rectangular and wherein the first, second and third conductors are normal to the planes of the first and second loops.

18. An MRI quadrature coil comprising:

a first loop conductor having consecutive first, second, third and fourth sides, the first loop conductor having a first gap at the first side, the ends of the loop at the gap forming a first and second terminal;

a second loop conductor opposed to the first loop conductor about an imaging volume also having consecutive first, second, third and fourth sides, the second loop conductor having a second gap at the first side, the ends of the second loop at the gap forming a third and fourth terminal;

a first conductor joining the first terminal to the third terminal;

a second conductor joining the second terminal to the fourth terminal; and

a third loop conductor positioned between the first and second loop conductors in opposition to the first and second loop conductors to bifurcate the imaging volume;

wherein the first and second loops have a resonant mode sensitive to changing magnetic vector along a first axis; and

wherein the third loop conductor has a resonant mode sensitive to a changing magnetic vector along a second axis substantially perpendicular to the first axis.

19. The MRI quadrature coil of claim 18 including a first capacitor joining the midpoints of the first and second conductors across which a signal indicating the changing magnetic vector along the first axis may be developed and including a second capacitor breaking the third loop conductor across which a signal indicating the changing magnetic vector along the second axis may be developed.

20. The MRI quadrature coil of claim 18 wherein the first, second and third loops are planar and rectangular and parallel to each other.

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L6: Entry 33 of 33 File: USPT Mar 6, 1990

DOCUMENT-IDENTIFIER: US 4906931 A
TITLE: Apparatus and method for the examination of properties of an object

Abstract Text (1):
The invention relates to an apparatus for the examination of an object by the application of methods, such as magnetic imaging, based on nuclear magnetic resonance. The apparatus includes means for creating a first magnetic field over an object to be examined as well as means for creating and registering a nuclear magnetic resonance signal. The apparatus further includes means for creating a second magnetic field in a manner that the formation of nuclear magnetization occurring between successive excitation and signal pick-up events is at least partially effected while the second magnetic field is switched on.

Brief Summary Text (1):
The present invention relates to an apparatus for and a method of improving the signal-to-noise ratio of tests based on nuclear magnetic resonance when examining properties of an object.

Brief Summary Text (2):
Ever since the 1950s, nuclear magnetic resonance phenomenon, has been an important method for examining matter. Magnetic imaging (is one application of nucleor magnetic resonance. Magnetic imaging previously also called nuclear spin imaging) is a novel non-destructive examination method, one of the most important applications of which is medical diagnostics. The principle of magnetic imaging was introduced by P. Lauterbur in 1973 (Lauterbur: Nature vol. 242, Mar. 16, 1973). Prior to this, R. Damadian had disclosed an operating idea for a sort of examination apparatus based on NMR (Nuclear Magnetic Resonance) phenomenon (Damadian: U.S. Pat. No. 3 789 832). A plurality of magnetic imaging methods or examination methods based on NMR have been developed and described in references: Ernst: U.S. Pat. No. 4 070 611, Garroway et al: U.S. Pat. No. 4 021 726, Moore edt al: U.S. Pat. No. 4 015 196.

Brief Summary Text (3):
Magnetic imaging, the same as other NMR examination methods, is based on the fact that the nuclei of certain elements have a magnetic moment. Such elements include e.g. hydrogen, carbon, sodium, potassium, phosphor and fluorine. NMR phenomenon has been described in several references: Abragam: The principles of nuclear magnetism, Oxford, Clarendon Press 1961, Dixon et al: Med. Phys. vol. 9, pp. 807-818, 1982, Farrar et al: Pulse and Fourier transform NMR, New York, Academic Press, 1971, Michel: Grundlagen und Methoden der kernmagnetischen Resonanz, Berlin, Akademie-Verlag, 1981 and Slichter: Principles of magnetic resonance, Berlin, Springer Verlag, 1980.

Brief Summary Text (4):
Magnetic imaging has also been explained in several references: Battocletti: CRC Cit. Rev. Biomed. Eng., vol. 11, pp. 313-361, 1984, Bottomley: Rev. Sci. Instrum., vol. 53, pp. 1319-1137, 1982, Hinshaw et al: Proc IEEE, vol. 71, pp. 338-350, 1983 and Mansfield et al: NMR imaging in biomedicine. Waugh, J S (ed), Advances in magnetic resonance, New York, Academic Press, 1982.

Brief Summary Text (5):
It is well-known that a signal-to-noise ratio obtainable in NMR tests depends on the intensity of a polarizing magnetic field (Bo). Theoretically, the signal-to-noise ratio is proportional to the square of a magnetic field. In practice, electrical dissipations created in a signal coil and in an object to be examined decrease

dependence. Thus, for example, the signal-to-noise ratio in imaging a human body is directly proportional to the intensity of Bo. The increase of an artifact created by the absolute inhomogeneity of a magnetic field and so-called chemical transition may diminish the dependence of a signal-to-noise ratio to the square or cubic root of Bo. The above viewpoints have been described e.g. in the following references: Hoult et al: J. Magn. Reson., vol. 34, pp. 425-433, 1979 and Hoult et al: Proc. 3rd Annual Meeting of Soc. Magn. Reson. in Medicine, August 13-17, New York, USA, 1984, pp. 148-152. The effect of the bandwidth of a signal coil and a signal on the signal-to-noise ratio and certain technical solutions associated therewith have been dealt with e.g. in references: Sepponen: U.S. Pat. No. 4 587 493 and U.S. Pat. No. 4 626 784.

Brief Summary Text (8):
Objects of the invention are accomplished by what is set forth in more detail in claim 1 and in the subclaims. An arrangement of the invention can be used to increase the signal-to-noise ratio in tests based on nuclear magnetic resonance without having to boost a magnetic field Bo existing during the observation of a resonance signal.

Drawing Description Text (2):
FIG. 1 shows a magnetic imaging apparatus, wherein a homogeneous and constant-intensity polarizing magnetic field Bo is produced by a magnet 20 to which is connected a power source 22. A magnetic coil BC produces over the object a second polarizing magnetic field Bp. In current required by magnetic coil 24 is supplied by a power source 26 controlled by a central processor 28. Location information is coded in a nuclear magnetic signal by gradient coils 30 to which are connected sets of power sources 32 controlled by central processor 28. The nuclear magnetic resonance signal is received by means of a signal coil SC which is connected via a coupler 36 to a signal amplifier 38 coupled with a phase-sensitive detector 40, the quadrature components of a signal obtained therefrom being transmitted via analog to digital converters 421 to central processor 28 which uses the stored signals to produce an image of e.g. the nuclear density of an object shown on a display 44 and stored in a memory unit 46. The excitation of nuclear magnetization is effected by a transmitter unit 48 which is controlled by central producessor 28. The excitation pulse is passed via coupler 36 to signal coil 34.

Drawing Description Text (3):
FIG. 2 shows a pulse sequence of one possible mode of operation for the apparatus, wherein BC represents the times at which a magnetic field Bp is switched on, RF represents the times at which the object is supplied with excitation pulses, Gx, Gy, Gz represent the times at which different gradient fields are switched on and D represents the times at which nuclear magnetic resonance signal is stored.

Drawing Description Text (6):
FIG. 5 shows one possible apparatus for imaging the head. The signal coil SC can be a so-called saddle coil or two quadrature-connected saddle coils or a set of signal coils as described in reference Savolainen. The set of coils BC producing magnetic field Bp can be a so-called Helm-holz coil or a solenoid, coil; the coils of these two sets are parallel to each other.

Drawing Description Text (7):
FIGS. 6A and 6B show a coil assembly suitable e.g. for the examination of the eye of a person P. Both the signal coil SC and the coils BC producing magnetic field Bp are solenoids which are orthogonal to each other.

Detailed Description Text (1):
As illustrated in the above figures, an apparatus of the invention for the examination of nuclear magnetic resonance phenomenon includes equipment for generating a polarizing magnetic field Bo. The increase of a signal-to-noise ratio is based on the fact that nuclear magnetization is allowed to form (to relax) for at least part of the duration of an operating cycle in the resultant field of magnetic fields Bo and Bp. The duration of an operating cycle is TR, corresponding e.g. to a span between the successive phases 2 shown in FIG. 2, and magnetic field Bp is switched on during phase 1. Thus, a signal that is attained will be

Detailed Description Text (9):
Benefits of the invention are most evident in cases where a target area to be examined is just a limited section of an object to be examined. Thus, when examining e.g. a human head, a set of coils producing magnetic field Bp can be relatively

compact and simple (e.g. set of Helmholz coils) and the required electric power is low (e.g. for a 0.05T field having a diameter of circa 400 mm power is circa 1kW). The magnet for generating magnetic field Bo can be a solenoid, which can accommodate a person to be examined and which produces a field that fulfils the requirements of imaging methods e.g. in terms of stability and homogeneity. The set of signal coils may comprise a simple saddle coil, a more sophisticated quadrature coil or a so-called "wave wound" coil described in reference Savolainen: U.S. Pat. No. 4 654 596. This application is shown in FIG. 5.

Detailed Description Text (11):
A coil producing the magnetic field Bp can also serve as a coil for excitation of the nuclear spin system and a coil for detection of the resulting NMR signal. This type of technique of the invention is illustrated in FIG. 8. A power supply 26 is controlled by central processor 28 and supplies current via the safety and anti-noise circuits built by diodes D and coils L1, L2, L3 as well as capacitors C2, C3 to a coil SB which generates magnetic field Bp. SB serves also as an excitation coil under the control of a transmitter 48 coupled via capacitor C and signal amplifier 50 is coupled via C4 and C5 to receive a resonance signal. The excitation and amplification systems for equipment based on the nuclear magnetic resonance phenomenon are described e.g. in reference Hoult: Prog. in NMR Spectroscopy, vol. 12, p. 41-77, 1978.

CLAIMS:

1. Apparatus for examining an object by means of nuclear magnetic resonance based techniques, including magnetic resonance imaging, said apparatus providing an improved signal-to-noise ratio and comprising:

means for generating a first polarizing magnetic field and for applying same to the object undergoing examination;

means for generating magnetic field gradients for said first polarizing magnetic field;

means for generating a second polarizing magnetic field for application to said object;

means for exciting the nuclear spin system of said object and detecting the resulting nuclear magnetic resonance signal; and

means controlling the operation of said magnetic field gradients generating means, said exciting and detecting means, and said second polarizing magnetic field generating means for applying said second polarizing magnetic field to said object prior to but not during nuclear spin system excitation, magnetic field gradient generation, and nuclear magnetic resonance signal detection.

5. The apparatus according to claim 1 wherein said means for generating said first polarizing magnetic field comprises one of an electromagnetic coil and a permanent magnet, the homogeneity and stability of said first polarizing magnetic field generating means being selected in accordanced with the nuclear magnetic resonance technique employed for examination.

8. A method for examining an object by means of nuclear magnetic resonance based techniques, including magnetic resonance imaging, said method providing an improved signal-to-noise ratio and comprising the steps of:

generating a first polarizing magnetic field and applying same to the object undergoing examination;

generating magnetic field gradients for the first polarizing magnetic field;

generating a second polarizing magnetic field for application to said object;

exciting the nuclear spin system of said object and detecting the resulting nuclear magnetic resonance signal; and

controlling the generation of the magnetic field gradients, the excitation of the nuclear spin system and detection of the resulting nuclear magnetic resonance signal, and the generation of the second polarizing magnetic field for applying the

second polarizing magnetic field to said object prior to but not during nuclear spin system excitation, magnetic field gradient generation, and nuclear magnetic resonance signal detection.

12. The method according to claim 8 wherein the step of generating the first polarizing magnetic field is further defined as generating the field by means of one of an electromagnetic coil and a permanent magnet, and as selecting the homogeneity and stability of the means used to generate the first polarizing magnetic field in accordance with the nuclear magnetic resonance technique employed for examination.

13. The method according to claim 8 further defined as employing a common element to generate the second polarizing magnetic field, excite the nuclear spin system and detect the resulting nuclear magnetic resonance signal.